WHAT IS CLAIMED IS:

1. A tracking error detection apparatus comprising:

a photodetector comprising four photoreceptor elements which are partitioned along a tangential direction and a perpendicular direction with respect to an information track that is recorded as an information pit line on a recording medium;

zerocross detection circuits for detecting zerocross points at which two sequences of digital signals intersect center levels of the respective digital signals, each of said two sequences of digital signals being obtained by adding output signals from the two photoreceptor elements positioned on a diagonal line, among four signals that are generated according to the amounts of light received by the respective photoreceptor elements and are outputted from the photodetector;

a phase difference detection circuit for performing phase comparison using a distance between the zerocross points of the two sequences of digital signals, and limiting the result of phase comparison to a value under a first predetermined value when the result of phase comparison is larger than the first predetermined value; and

a low-pass filter for performing band restriction to a signal outputted from the phase difference detection circuit, thereby to obtain a tracking error signal.

2. A tracking error detection apparatus as defined in Claim 1

wherein said phase difference detection circuit comprises:

a phase difference calculation unit for calculating a distance between the zerocross points of the two sequences of digital signals, and successively outputting the distance as a result of phase comparison;

a pulse generation unit for generating pulse signals each corresponding to one sampling clock at positions where the two sequences of digital signals perform zerocross, respectively, and outputting, as a phase comparison end pulse, a pulse signal that appears later at a point where phase comparison is carried out, between the generated pulse signals corresponding to the two sequences of digital signals;

a data updation unit for updating the output data using the result of phase comparison which is successively outputted from the phase difference calculation unit, at every phase comparison end pulse outputted from the pulse generation unit, and maintaining the output level of the output data until the next phase comparison end pulse arrives; and

a limit control unit for judging whether the output signal from the data updation unit is larger than the first predetermined value or not, and limiting the output signal to a value under the first predetermined value when the output signal is larger than the first predetermined value.

3. A tracking error detection apparatus as defined in Claim 2

wherein the first predetermined value of the limit control unit is set on the basis of the relationship between a shortest pit length and a track pitch of an optical disc to be played.

4. A tracking error detection apparatus comprising:

a photodetector comprising four photoreceptor elements which are partitioned along a tangential direction and a perpendicular direction with respect to an information track that is recorded as an information pit line on a recording medium;

zerocross detection circuits for detecting zerocross points at which two sequences of digital signals intersect center levels of the respective digital signals, each of said two sequences of digital signals being obtained by adding output signals from the two photoreceptor elements positioned on a diagonal line, among four signals that are generated according to the amounts of light received by the respective photoreceptor elements and are outputted from the photodetector;

an edge detection circuit for detecting the states of edges to be used for phase comparison, using binary signals of sampling data of the two sequences of digital signals;

a phase difference detection circuit for performing phase comparison using a distance between the zerocross points of the two sequences of digital signals; and

a low-pass filter for performing band restriction to the signal outputted from the phase difference detection circuit,

thereby to obtain a tracking error signal;

wherein said phase difference detection circuit judges whether the edges to be the targets of phase comparison are valid as edges for phase comparison or not on the basis of the states of the edges detected by the edge detection circuit, and does not carry out output/updation of the phase comparison result at the edges judged as "invalid".

5. A tracking error detection apparatus as defined in Claim 4 wherein said phase difference detection circuit comprises:

a phase difference calculation unit for calculating a distance between the zerocross points of the two sequences of digital signals, and successively outputting the distance as a result of phase comparison;

a pulse generation unit for generating pulse signals each corresponding to one sampling clock at positions where the two sequences of digital signals perform zerocross, respectively, and outputting, as a phase comparison end pulse, a pulse signal that appears later at a point where phase comparison is carried out, between the generated pulse signals corresponding to the two sequences of digital signals;

an invalid edge cancel unit for judging whether the edges to be the targets of phase comparison are valid as edges for phase comparison or not, on the basis of the states of the edges detected by the edge detection circuit; and

a data updation unit operating at every phase comparison end pulse outputted from the pulse generation unit, said data updation unit updating the output data using the result of phase comparison that is outputted from the phase difference calculation unit, and maintaining the output level of the output data until the next phase comparison end pulse arrives, when the result of judgement by the invalid edge cancel unit is "valid", while maintaining the output level of the data that has been outputted at the just-previous phase comparison end pulse, when the result of judgement in the invalid edge cancel unit is "invalid".

6. A tracking error detection apparatus as defined in Claim 5 wherein

said edge detection circuit detects, from an edge falling position of a signal including a preceding edge, the state of another signal at each point where a phase difference is to be detected, and outputs a signal indicating that the edges of these signals are aligned with each other or that the level of the other signal is "1" or "0"; and

said invalid edge cancel unit judges the edges as valid edges when the edges are aligned with each other or when the level of the other signal is "1", and judges the edges as invalid edges when the level of the other signal is "0", on the basis of the output from the edge detection circuit.

7. A tracking error detection apparatus as defined in Claim 5 wherein

said edge detection circuit detects rising edges or falling edges of binary signals of sampling data of the two sequences of digital signals, and outputs a signal indicating whether or not a distance between the detected rising or falling edges is equal to or smaller than a second predetermined value; and

said invalid edge cancel unit judges the edges as valid edges when the distance between the rising or falling edges is equal to or smaller than the second predetermined value, and judges the edges as invalid edges when the distance is larger than the second predetermined value, on the basis of the output from the edge detection circuit.

8. A tracking error detection apparatus comprising:

a photodetector comprising four photoreceptor elements which are partitioned along a tangential direction and a perpendicular direction with respect to an information track that is recorded as an information pit line on a recording medium;

zerocross detection circuits for detecting zerocross points at which four sequences of digital signals intersect center levels of the respective digital signals, said four sequences of digital signals being generated according to the amounts of light received by the respective photoreceptor elements and are

outputted from the photodetector;

a first phase difference detection circuit for performing phase comparison using a distance between the zerocross points of two sequences of digital signals that are obtained from the photoreceptor elements positioned forward in the advancing direction of the information track, among the zerocross points of the four sequences of digital signals, and limiting the result of phase comparison to a value under the first predetermined value when the result of phase comparison is larger than the first predetermined value; and

a second phase difference detection circuit for performing phase comparison using a distance between the zerocross points of two sequences of digital signals that are obtained from the photoreceptor elements positioned backward in the advancing direction of the information track, among the zerocross points of the four sequences of digital signals, and limiting the result of phase comparison to a value under the first predetermined value when the result of phase comparison is larger than the first predetermined value;

an addition circuit for adding the output signals of the first and second phase difference detection circuits; and

a low-pass filter for performing band restriction to the signal outputted from the addition circuit, thereby to obtain a tracking error signal.

9. A tracking error detection apparatus as defined in Claim 8 wherein each of said first and second phase difference circuits comprises:

a phase difference calculation unit for calculating a distance between the zerocross points of the two sequences of digital signals, and successively outputting the distance as a result of phase comparison;

a pulse generation unit for generating pulse signals each corresponding to one sampling clock at positions where the two sequences of digital signals perform zerocross, respectively, and outputting, as a phase comparison end pulse, a pulse signal that appears later at a point where phase comparison is carried out, between the generated pulse signals corresponding to the two sequences of digital signals;

a data updation unit for updating the output data using the result of phase comparison which is successively outputted from the phase difference calculation unit, at every phase comparison end pulse outputted from the pulse generation unit, and maintaining the output level of the output data until the next phase comparison end pulse arrives; and

a limit control unit for judging whether the output signal from the data updation unit is larger than the first predetermined value or not, and limiting the output signal to a value under the first predetermined value when the output signal is larger than the first predetermined value.

10. A tracking error detection apparatus as defined in Claim 9, wherein the first predetermined value of the limit control unit is set on the basis of the relationship between a shortest pit length and a track pitch of an optical disc to be played.

11. A tracking error detection apparatus comprising:

a photodetector comprising four photoreceptor elements which are partitioned along a tangential direction and a perpendicular direction with respect to an information track that is recorded as an information pit line on a recording medium;

zerocross detection circuits for detecting zerocross points at which four sequences of digital signals intersect center levels of the respective digital signals, said four sequences of digital signals being generated according to the amounts of light received by the respective photoreceptor elements and are outputted from the photodetector;

a first edge detection circuit for detecting the states of edges to be used for phase comparison, using binary signals of sampling data of two sequences of digital signals that are obtained from the photoreceptor elements positioned forward in the advancing direction of the information track, among the four sequences of digital signals;

a second edge detection circuit for detecting the states of edges to be used for phase comparison, using binary signals of

sampling data of two sequences of digital signals that are obtained from the photoreceptor elements positioned backward in the advancing direction of the information track, among the four sequences of digital signals;

a first phase difference detection circuit for performing phase comparison using a distance between the zerocross points of the two sequences of digital signals that are obtained from the photoreceptor elements positioned forward in the advancing direction of the information track, among the zerocross points of the four sequences of digital signals, and outputting the result of phase comparison;

a second phase difference detection circuit for performing phase comparison using a distance between the zerocross points of the two sequences of digital signals that are obtained from the photoreceptor elements positioned backward in the advancing direction of the information track, among the zerocross points of the four sequences of digital signals, and outputting the result of phase comparison;

an addition circuit for adding the output signals of the first and second phase difference detection circuits; and

a low-pass filter for performing band restriction to the signal outputted from the addition circuit, thereby to obtain a tracking error signal;

wherein said first phase difference detection circuit judges whether the edges to be the targets of phase comparison are valid

as edges for phase comparison or not, on the basis of the states of edges detected by the first edge detection circuit, and does not perform output and updation of the result of phase comparison at the edges that are judged as invalid by the judgement; and

said second phase difference detection circuit judges whether the edges to be the targets of phase comparison are valid as edges for phase comparison or not, on the basis of the states of edges detected by the second edge detection circuit, and does not perform output and updation of the result of phase comparison at the edges that are judged as invalid by the judgement.

12. A tracking error detection apparatus as defined in Claim 11 wherein each of said first and second phase difference detection circuits comprises:

a phase difference calculation unit for calculating a distance between the zerocross points of the two sequences of digital signals, and successively outputting the distance as a result of phase comparison;

a pulse generation unit for generating pulse signals each corresponding to one sampling clock at positions where the two sequences of digital signals perform zerocross, respectively, and outputting, as a phase comparison end pulse, a pulse signal that appears later at a point where phase comparison is carried out, between the generated pulse signals corresponding to the two sequences of digital signals;

an invalid edge cancel unit for judging whether the edges to be the targets of phase comparison are valid as edges for phase comparison or not, on the basis of the states of edges detected by the first or second edge detection circuit; and

a data updation unit operating at every phase comparison end pulse outputted from the pulse generation unit, said data updation unit updating the output data using the result of phase comparison outputted from the phase difference calculation unit, and maintaining the output level of the output data until the next phase comparison end pulse arrives, when the result of judgement by the invalid edge cancel unit is "valid", while maintaining the output level of the data outputted at the just-previous phase comparison end pulse, when the result of judgement by the invalid edge cancel unit is "invalid".

13. A tracking error detection apparatus as defined in Claim 12, wherein

each of said first and second edge detection circuits detects, from an edge falling position of a signal including a preceding edge, the state of another signal at each point where a phase difference is to be detected, and outputs a signal indicating that the edges of these signals are aligned with each other or that the level of the other signal is "1" or "0"; and

said invalid edge cancel unit judges the edges as valid edges when the edges are aligned with each other or when the level of

the other signal is "1", and judges the edges as invalid edges when the level of the other signal is "0", on the basis of the output from the edge detection circuit.

14. A tracking error detection apparatus as defined in Claim 12 wherein

each of said first and second edge detection circuits detects rising edges or falling edges of binary signals of sampling data of the two sequences of digital signals, and outputs a signal indicating whether or not a distance between the detected rising or falling edges is equal to or smaller than a second predetermined value; and

said invalid edge cancel unit judges the edges as valid edges when the distance between the rising or falling edges is equal to or smaller than the second predetermined value, and judges the edges as invalid edges when the distance is larger than the second predetermined value, on the basis of the output from the edge detection circuit.